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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/602,291	06/24/2003	Elizabeth A. Dauch	NEC0252US	1241

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EXAMINER	
GURLEY, LYNNE ANN	
ART UNIT	**PAPER NUMBER**
2812	

DATE MAILED: 03/17/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/602,291	DAUCH ET AL.	
	Examiner	Art Unit	
	Lynne A. Gurley	2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *05 December 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-9 and 27-37* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-9 and 27-37* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

LYNNE A. GURLEY
PRIMARY PATENT EXAMINER
TC 2800, AU 2812

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *12/5/05*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

This Office Action is in response to the amendment with remarks, filed 12/5/05.

Currently, claims 1-9 and 27-37 are pending.

Specification

1. The specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Information Disclosure Statement

2. The information disclosure statement (IDS) submitted on 12/5/05 was filed after the mailing date of the non-final office action on 7/13/05. In part, the submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner, except for the two references listed with incorrect numbers.

3. The information disclosure statement filed 12/5/05 in part fails to comply with the provisions of 37 CFR 1.97, 1.98 and MPEP § 609 because two of the references listed have incorrect numbers US 6,872,699 and US 2004/0152395 are by different inventors than listed by Applicant and contain entirely unrelated subject matter to the instant application. It has been placed in the application file, but the information referred to therein has not been considered as to the merits. Applicant is advised that the date of any re-submission of any item of information contained in this information disclosure statement or the submission of any missing element(s) will be the date of submission for purposes of determining compliance with the requirements

based on the time of filing the statement, including all certification requirements for statements under 37 CFR 1.97(e). See MPEP § 609.05(a).

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 1, 5-9, 32, and 36-37 are rejected under 35 U.S.C. 102(b) as being anticipated by Muranaka et al. (US 6,358,329, dated on 3/19/02).

Muranaka shows the method as claimed in figures 1-5 and corresponding text, with W plug 2/3 (fig. 5) and conductive interconnect 5/5a. Embodiment 4 (column 4, lines 65- column 5, lines 1-14) shows a rinsing and/or washing method, where the rinsing or washing fluid may be ultrapure water or a solution for rinsing or a combination thereof. The rinsing step is 3 minutes or less. Therefore, the rinsing step, for less than 3 minutes, performed in ultrapure water, and followed by the washing step in a solution is shown. The water is neither degasified nor deionized.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person

having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

8. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

9. Claims 2-4, 27-31 and 33-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Muranaka et al. (US 6,358,329, dated 3/19/02) in view of Wang et al. (US 6,277,742, dated 8/21/01).

10. Muranaka shows the method substantially as claimed and as shows in the preceding paragraphs.

Muranaka lacks anticipation only in not teaching that 1) the liquid water is degasified and deionized; 2) the liquid water is deionized but not degasified; 3) the liquid water is degasified but not deionized; and 4) the liquid water has a pH slightly less than neutral.

Wang teaches the removal of polymer residues from an interconnect overlying a W plug using an electrolytic solution which is either acidic or basic, in order to avoid corrosion of the overlying interconnect (column 1, lines 49-62; column 3, lines 50-67; column 3, lines 1- 9). The solution is purposefully not neutral so that corrosion does not damage the interconnect.

It would have been obvious to one of ordinary skill in the art to have used a liquid water having a pH slightly less than neutral, in the method of Muranaka, with the motivation given by Wang in that the adjusted pH of the water, which is naturally an electrolyte, would prevent corrosion of the interconnect.

It would have also been obvious to have the liquid water be degasified and deionized; deionized but not degasified; or degasified but not deionized, in the method of Muranaka, with the motivation that changes or various combinations of the ionization and gasification of the liquid water would also effect the corrosion and the amount of charge which would effect the overall performance of the device.

11. Claims 1-9 and 27-37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mautz et al. (US 5,476,816, dated 12/19/95) in view of Tsai et al. (US 6,410,417, dated 6/25/02) and further in view of the Admitted Prior Art (specification ,pages 2 [0009] – page 3 [0011].

Mautz shows the method as claimed in Figures 3-6 and corresponding text as: forming a tungsten plug 32/31 in a dielectric layer 28; forming an electrically conductive interconnect line 41 on the dielectric layer after formation of the tungsten plug, wherein the tungsten plug is electrically connected to the electrically conductive interconnect line; contacting the electrically conductive interconnect line with liquid water after formation of the electrically conductive

interconnect line; contacting the electrically conductive interconnect line with a solution after the electrically conductive interconnect line is contacted with the liquid water (column 6, lines 25-30, lines 45-62; column 7, lines 1-16); wherein the electrically conductive interconnect line is contacted with the liquid water for less than 120 minutes (claim 1; column 4, lines 2-27; column 5, lines 30-35, lines 53-56; column 6, lines 2-4, lines 28-29, lines 45-61; column 7, lines 2-17). The liquid water is deionized and degasified, and may contact the interconnect for 60-120 seconds or 45-120 seconds or 1-10 minutes (claims 1-2, and 7-8). The claimed interconnect materials are used (claim 9; column 4, lines 8-27). Liquid water inherently has a pH equal to 7, which is neutral (claim 6).

Mautz lacks anticipation only in not teaching, or explicitly teaching that: 1) the solution contacting the electrically conductive interconnect line removes residual polymer; 2) the liquid water is deionized but not degasified; 3) the liquid water is degasified but not deionized; and, 4) the liquid water is neither degasified nor deionized.

Tsai teaches, in figs. 1-4 and corresponding text, a similar tungsten plug and subsequent interconnect formation method. Emphasis is placed on the fact that Tsai teaches conventional processing for tungsten plug and interconnect devices and, the results of the processing steps, wherein after patterning the metal interconnect over the via plugs, the photoresist is removed by ashing, which often leaves a polymer residue on the surface of the wafer to be subsequently removed by a wet stripper (i.e., a solvent, alkaline, etc.) (column 1, lines 34-60). In addition to the polymer residue, the ashing process additionally results in an increase in the charge on the wafer (column 1, lines 45-48). The photoresist is removed by ashing with oxygen plasma and water vapor or water plasma, after patterning the interconnect. The water vapor or water plasma

is used to reduce the amount of wafer charging and to protect the tungsten from erosion in case of misalignment as seen in fig. 4 (column 2, lines 1-10 and lines 50-61; column 3, lines 10-35).

The Admitted Prior Art teaches that the residual polymer residue on the interconnect is inherently formed and conventionally a problem to one of ordinary skill in the art [0010]; and, that conventionally an alkaline or basic solution (pH greater than 7) or, and acidic solution (pH less than 7) is used to eradicate the residue [0011].

It would have been obvious to one of ordinary skill in the art to have incorporated, in the method of Mautz, a solution contacting the electrically conductive interconnect line to remove residual polymer (which is inherently present on the interconnect as a result of conventional patterning, as taught by the Admitted Prior Art), as taught in the method of Tsai, with the motivation that Tsai teaches that the solution removes the polymer residue resulting from a conventional resist ashing process, such as the conventional ashing process shown in Mautz. Additionally, one of ordinary skill in the art would find motivation to incorporate the polymer removing solution, taught in Tsai, within the framework of the liquid water and solution exposure steps in Mautz, since Mautz teaches that liquid water rinsing is performed before the exposure of the substrate to a solution which removes contaminants such as mobile ions on the substrate (column 4, lines 66-67; column 5, lines 1-3 and lines 23-67; column 6, lines 1-3). The residual polymer is considered to one of ordinary skill in the art to be a form of contaminant and, the solvent, which Mautz uses, removes the contaminants and contains alcohols (column 5, lines 40-51) which are naturally basic and alkaline, such as the polymer removing solution exemplified in Tsai. In general, Tsai makes it clear that the polymer removal step is necessary as a separate step from the ashing step (column 3, lines 40-43). The ashing step is used to reduce

the charge on the wafer in Tsai, just as the solvent exposure, in the wafer cleaning step, is used in part to reduce the wafer charge in Mautz. The two processes are compatible because they both seek to reduce the wafer charge in similar tungsten plug/interconnect processes and taken as a whole, both teach and acknowledge that solutions used after the ashing process are necessary to clean the substrate of contaminants, to remove charges on the wafer and to remove residual polymer. To further add a step to the process of Mautz to remove the polymer residue after the ashing step would be obvious in addition to removing the harmful charge on the wafer.

It would have also been obvious to one of ordinary skill in the art to have modified the properties of the water in the method of Mautz, pertaining to ionization and degasification and slightly less or more pH, with consideration for possible tungsten erosion and misalignment as taught by Tsai and as taught by the Admitted Prior Art, which shows that both acidic and basic/alkaline solutions benefit the polymer removal and, with the motivation that changing these parameters would offer additional control in the amount of charged particles desired on the surface of the interconnect, especially since Tsai teaches that the water vapor or water plasma is useful for decreasing the wafer charge due to the ashing step.

Response to Arguments

12. Applicant's arguments filed 12/5/05 have been fully considered but they are not persuasive.

13. In response to Applicant's remarks, pages 6-7, the Examiner has cited important and relevant prior art, which not only addresses the same problems associated with Applicant's prior art, but also meets the limitations of Applicant's claimed invention. The Examiner has also

pointed to relevant areas of the Muranaka reference, especially the 4th embodiment in the reference. Muranaka is not a complex reference as Applicant has stated. Muranaka shows the invention as claimed. Specifically, figure 5 shows the W plug 3 in ILD 1, barrier layer 4, aluminum interconnect 5/5a, which is the structure being processed by all embodiments, in order to remove the polymer residue produced by the patterning of the interconnect 5/5a. The 4th embodiment (column 4, lines 65-67 and column 5, lines 1-20) may be used in combination with any of the preceding 1st-3rd embodiments. As stated in the 4th embodiment, a rinsing step in ultrapure water, a fluid specifically designed for rinsing purposes, or a combination thereof, when administered at a temperature of 20 degrees or less, takes the place of the residual removal fluid (column 3, lines 39-47) in, for example step one of the 1st embodiment. So that the step in the 4th embodiment (i.e. ultrapure water rinse) is first, then the rinsing step, then the draining step and then the water-washing step, following the rest of the first embodiment. Column 5, lines 15-20 in the reference, indicates that this substitution is possible. Column 5, lines 11-14 indicates that this substitution is desirable because it further prevents the corrosion of the interconnect ("sufficient substitution of the residual removal fluid can be effected", as stated in column 5, lines 13-14). The substituted ultrapure water step then becomes the first cleaning step and is administered for less than 3 minutes (column 5, lines 9-11). Any step following the ultrapure water step, whether being by the fluid specifically designed for rinsing in the 4th embodiment, or whether being by the steps 2-4 remaining in the 1st embodiment would meet the requirement of "contacting the electrically conductive interconnect line ***with a solution to remove residual polymer*** **after** the electrically conductive interconnect line is contacted with the liquid water". This limitation is met because any of the solutions in the further rinsing step, or the water-

washing step is designed to further remove the residual polymer and all of these steps occur after the exposure to the ultrapure water for less than 3 minutes. Similarly, the ultrapure water step of the fourth embodiment may be applied to replace the 1st removal fluid processing step in the third embodiment (column 4, lines 45-50), followed by the washing fluid step of the 3rd embodiment. Additionally, the mere mention of "or a combination thereof" (column 5, lines 2-3) in the 4th embodiment, infers that the 4th embodiment enables an ultrapure water step followed by a rinse with the fluid specifically designed for rinsing purpose, which would also meet the claimed limitations. The claimed limitation of the "solution to remove residual polymer", which is applied after the liquid water step, is very broad and encompasses any rinsing or washing solution that is applied after the liquid water step, since all of these steps contain solutions which are used to remove residual polymer in their broadest interpretation, whether by rinsing, washing, etc. For these reasons, the Examiner considers that that the burden of proof has wholeheartedly been met, and that the Muranaka reference meets the limitations of the claimed invention in claims 1, 5-9, 32 and 36-37.

14. In response to Applicant's remarks, page 8, regarding Muranaka in view of Wang, Muranaka substantially shows the limitations of claim 27, except for the pH being slightly less than neutral. Wang is used to teach a slightly acidic or basic electrolyte solution to clean the residual polymer in order to avoid charges that accumulate otherwise on the interconnect. The solution discharges the charge accumulation. Column 1, lines 49-62 of the reference deals with the prior art solutions. The entire reference, including the abstract, states that the electrolyte solutions are either acid or alkaline enough to discharge the charges accumulated on the wire. Contrary to Applicant's statements that Wang only discloses a neutral ionic solution and an

alkaline electrolyte solution, column 2, lines 58-67 specifically states that the solution may be acidic, and when the solution is acidic, the solution has pH less than 6.5, which is less than neutral (pH = 7). Specific examples are given. Wang is used to teach the alteration of the water to be slightly acidic (pH<7) in order to allow the discharge of the accumulated charges on the interconnect and improve the reliability of the interconnect. It is well known in the art that these charges exist, and that they are produced by previous plasma etching/patterning processes, and that they must be dealt with to produce a reliable interconnect (column 1, lines 40-44). All of the steps in Wang also are directed to avoiding corrosion of a W plug with overlying interconnect. The fact that Muranaka states that a rinsing solution specifically designed for rinsing the substrate may be used in the 4th embodiment, suggests to one of ordinary sill in the art that the modification of the 4th embodiment to produce a slightly acidic (pH<7) liquid water, would also reduce the amount of accumulated charge on the interconnect, thereby producing a more reliable W plug/interconnect, which is the goal of both references, Muranaka and Wang, and an excellent reason to combine the two, with every reasonable expectation of success. The Examiner has met the burden to establish a prima facie case of obviousness in rejecting independent claim 27.

15. In response to Applicant's remarks, pages 7-8, and to further clarify the Examiner's position regarding the Mautz rejection, Mautz shows a residual resist removal step for a W plug 32 or 31 with overlying interconnect 412 or 411. After the interconnect patterning step, the following cleaning sequence is carried out: 1) deionized water rinse; 2) fluorine etching solution; 3) rinse, after etching solution exposure (column 5, lines 30-52). The last rinse may include an intermediate solvent rinse and another deionized water rinse (column 6, lines 45-67), so that the sequence becomes: 1)deionized water rinse; 2) fluorine etching solution (45-120

seconds or 60-120 seconds; column 6, lines 25-43); 3) intermediate solvent rinse; 4) another deionized water rinse. The exemplary time for rinsing is 1-10 minutes (column 6, lines 59-61). Additionally, other deionized rinses may be included in the process (column 7, lines 7-10) and, the process can be compacted (column 7, lines 10-16). The above sequence meets the claimed limitation, except for the explicit statement that there is actually a residual polymer, which is being removed as well. Rather than to state that the presence of residual polymer is obvious, especially considering the patterned photoresist and interconnect processing steps in the Mautz reference, the Examiner relied on Tsai and the Admitted prior art to teach that conventionally, the residual polymer has always been present and is a problem which is commonly addressed in W/interconnect structures. Therefore, Tsai is not relied upon for its use of solvent to remove the residual polymer. Instead, Tsai is relied upon for its **background teaching** that the same processing steps used to form the structure in Mautz, which are also used in Tsai, regarding the steps used to form W plug/interconnect structure, produce not only accumulation of charge on the wafer, as shown in Mautz (and in Tsai) but **also produce residual polymer residue**. This is what Tsai is relied on to bring to Mautz. Restated, the removal of resist by plasma ashing, which is used in Mautz (and in Tsai's background teaching), not only results in accumulation of charge on the interconnect, but **also results in residual polymer residue**. Mautz does not teach this explicitly by itself. The Examiner sought to use the Tsai reference to clarify and clearly state the duality of the problem. Therefore, even though Mautz does teach away from using the resist removal solvent, it is irrelevant because Tsai is only relied upon for its **background teaching** of the **conventional additional problem of residual polymer residues in combination with the charge accumulation**. Tsai is not relied on for its use of solvent. The Admitted Prior Art is

relied upon for support of the residual polymer residue as well. The Examiner takes the position that the background information provided to outline and describe the causes and exemplary solutions to a conventional problem, which is sought to be solved by all references involved, Mautz, Tsai and the Admitted Prior art, is a valid reason for combination of the references.

Conclusion

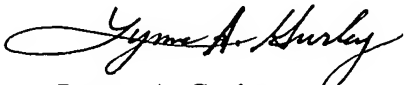
16. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lynne A. Gurley whose telephone number is 571-272-1670. The examiner can normally be reached on M-F 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Lebentritt can be reached on 571-272-1873. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Lynne A. Gurley
Primary Patent Examiner
TC 2800, Art Unit 2812

LAG
March 6, 2006